No. XXIII.

ON GEORGE FORRESTER AND CO.'S IMPROVED DOUBLE-CYLINDER MARINE ENGINE, INVENTED BY B. HICK, ESQ.

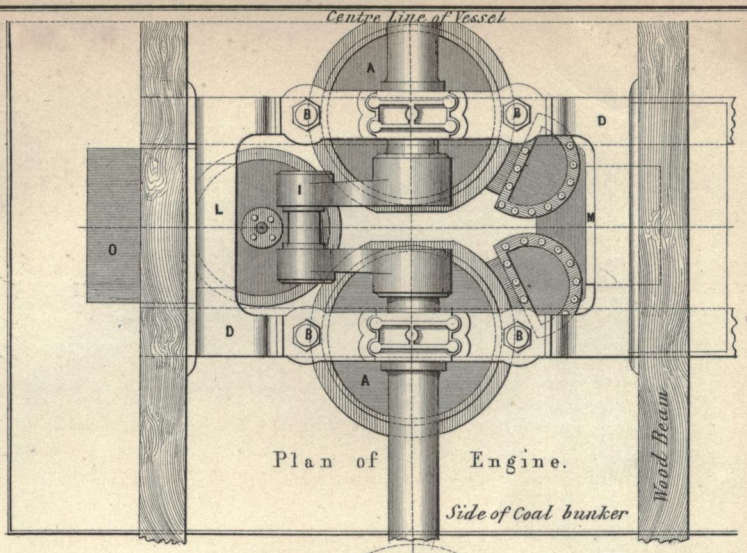
By B. Hick (of the above firm), Engineer.

March 20, 1844.

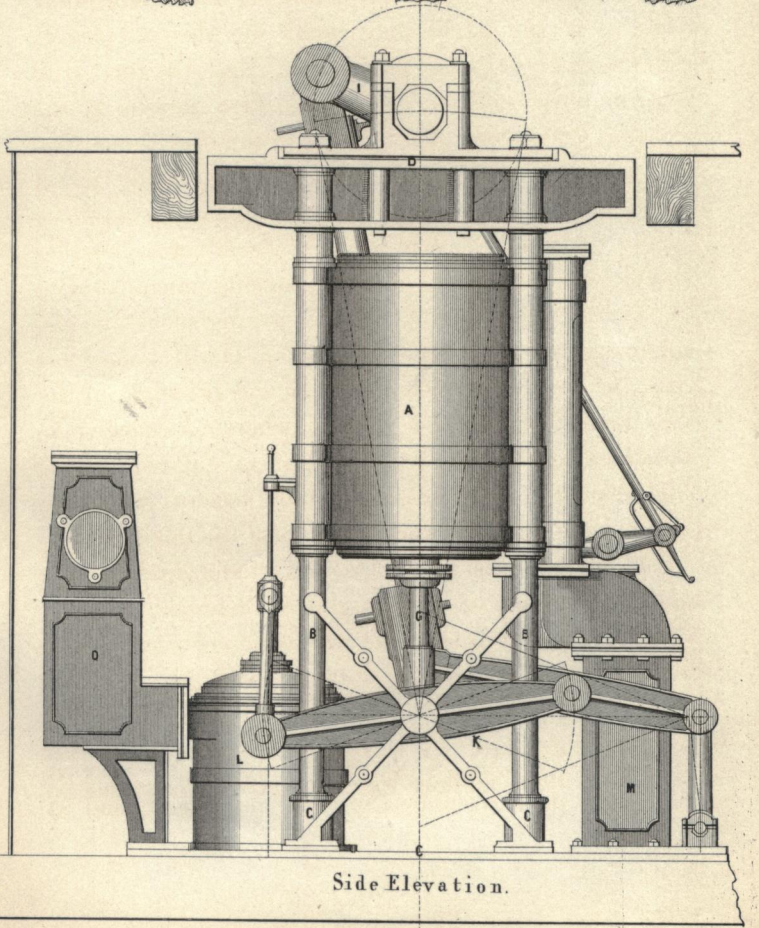
BENJAMIN BOND CABBELL, ESQ. F.R.S. V.P. IN THE CHAIR.

The engine, of which the following is a description, is one of a pair lately constructed by Messrs. George Forrester and Co. for the Helen Mac Gregor, Hull and Hamburg steamer. The collective power of the engines is 220 horses', the tonnage of the boat being 573. The engines are of the form usually denominated "direct action," and, without making any comparison between this and the various other forms of direct-action engines hitherto made (some of them possessing much that is admirable in the ingenuity of their arrangement and the compactness of their different parts), I will endeavour plainly to describe the construction and principle of the above-named engine, and to state wherein I conceive its advantages will be found, in practice, as suitable for sea-going steamers. The following short account will serve to explain the different working parts of the engine.

The engine consists of two inverted cylinders, *a a*, standing upon four strong wrought-iron columns, *b b*, &c., which rest on, and are secured to, the foundation-plate *c*, and which, passing through suitable bosses, on the sides of the cylinders, support the entablature-plate *d* and crank-pedestals above. The cylinders are placed "athwart ships," with their stuffing-boxes *e e* below them, and at



Plan of Engine.



Side Elevation.

Maclure, Macdonald & Macgregor, Lith.rs Edin.r & Glasgow

sufficient height from the bottom of the vessel to allow of the main cross-bar *f*, which connects together the two piston-rods *g g*, working the full length of its stroke below them; the stuffing-boxes *e e* are of double form, or, in other words, they have a space for packing both at top and bottom, being furnished with self-acting oil-cups for lubricating the rods. The power is transmitted directly, from the main cross-bar *f* below, to the cranks *i i* above the cylinders, by the connecting-rod *h*. The two piston-rods *g g*, and the connecting cross-bar *f*, are further secured, and made to work uniformly together, by means of a strong vibrating frame of cast-iron, forming part of the parallel motion, and which, with the side-levers *k*, serves also to work the air-pump *l*, as well as the feed, bilge, and brine-pumps. There is nothing new in the paddle-wheels, shafts, or bearings.

Each cylinder is furnished with a separate slide-valve, which two are connected together by a cross-bar common to both, being worked by the same eccentric motion. The object of thus dividing the valve is to shorten the lengths of the "steam ports," the valves being brought much closer up to the face of their respective cylinders than would be the case if one only were used for both. The condenser *m* is placed immediately underneath the slide-valve case, and the air-pump, foot, and discharge-valves, are similar in construction to those of the ordinary side-lever engines. The air-pump *l* and condenser *m* are connected together by a passage underneath the foundation-plate. The waste water is discharged from the hot well *o* by an overflow-pipe through the side of the vessel.

In order more clearly to explain the principle of this arrangement, and its applicability to "sea-going steamers,"

it will be necessary to advert to the following parts, which form the chief features, or novelty, in the engine.

1st. The cylinders and their position.

The application of two cylinders to one engine, having their piston-rods connected together, was first introduced by Messrs. Maudslay and Field, of London, for marine purposes, and is described in a patent taken out by them.

The advantage of the use of two cylinders, instead of one of double the capacity, has been much questioned; and, independently considered, such an arrangement would seem to involve at first sight only a useless complexity of parts, but, when it is remembered that in using two cylinders there may be considerable advantage derived from the simplification of the remaining parts of the engine, their introduction may be regarded as a very valuable addition to the various improvements which the steam-engine has from time to time undergone.

Although it is hardly to be supposed that in engines of the largest class there will ever be required a cylinder of larger dimensions than is practicable to be constructed all in one, yet it has been found in practice that there is considerable difficulty in making cylinders of very large diameter as perfectly true as those of more moderate dimensions, and in regard to pistons, two of forty-eight or fifty inches diameter are stronger (upon the same weight), and less liable to accident than one of double the area. The use of two cylinders to one engine enables the manufacturer to undertake the construction of engines of double the power, without incurring an increased outlay for new tools, and greatly increases the facility for repairs at the government stations abroad, as there will rarely be an instance of a cylinder, or other casting of

the double-cylinder engine, too large to be constructed in a moderate-sized establishment.

In the engine above described, the use of two cylinders is indispensable to the arrangement; they are here placed in a line below the crank-shaft, clear of the sweep of the cranks, the centre of each cylinder is in a line with the centre of the shaft journals, and the main columns, upon which they are mounted, pass upwards and are secured by nuts on their upper end to the crank-shaft pedestals immediately above them (as before described).

The proximity of the cylinders to the crank-shaft journals renders the rest of the engine perfectly free from the strain of its power.

In every description of engine, and more particularly of those used for marine purposes, this principle is of the greatest importance, as, the farther removed the cylinder is from the point to which its power has to be communicated, the more liable to breakage are all the parts of the framing between the cylinder and the crank, and the greater the friction arising from an increased number of working journals required to communicate the power from one to the other.

In some of the roughest seas, so well known between Hull and Hamburg, the engines in the Helen Mac Gregor do not seem to suffer the slightest strain in working. There is some novelty also in the mode of securing the cylinders in their places. Two bosses cast upon each cylinder, and extending from top to bottom, are accurately bored out to fit the main upright columns which pass through them, and rest upon projecting shoulders in the columns, being simply lowered down upon them without any holding-down bolt in the cylinder, and the entablature-plate and pedestals are secured imme-

diately above them by nuts and cotters in the column tops. This mode of fastening prevents any strain on the cylinder during erection, which frequently occurs in bolting them down in the ordinary way even when the greatest care is observed, as it is well known that a cylinder generally deviates from the truth of the boring-mill when the main cement-joint is made between its lower flange and the foundation-plate on which it rests, as in the ordinary engine.

The cylinders have loose covers at each end, and from the upper ends the pistons are accessible without the intervention of the piston-rods, so that there is double space for examining and adjusting them without disturbing the lower covers, or disconnecting any of the working parts of the engine.

The elevated position of the cylinders entirely obviates the danger sometimes arising from water running over into the cylinders from the boilers, as they are here at a higher level than the water-line, and an accident from this cause cannot occur. The cylinders are also so much higher than the condensers, that they are kept perfectly free from water in this respect,—an advantage well known to engineers who have the charge of marine engines.

2. In the length of the connecting-rod and mode of connexion between the pistons and the cranks, I think there is some advantage. The connecting-rod is three times the length of the stroke, and there is only one main working-joint besides that of the crank-pin through which the power is transmitted from the cross-head below; at this joint the motion is so slight, owing to the great length of the connecting-rod, that the friction upon it must be very inconsiderable. For the same reason the engine

maintains its power over a large paddle-wheel with more equality during the whole of its stroke. Engines with short connecting-rods are comparatively powerless, for a considerable portion of the stroke over the top centres.

In the engines of the Helen Mac Gregor the maximum speed is at the rate of twenty-four revolutions per minute in smooth water, and in the heaviest sea and with a head wind they have never fallen below eighteen or nineteen, and the little diminution which is produced upon the speed of the engines, by any sudden resistance to the wheels, seems to be attributable, in some measure, to the length of the connecting-rod and the slight angle it forms with the crank when in the middle of its stroke.

3. In the arrangement of the air-pump and condenser there is a great facility afforded for getting about them.

The foot and delivery-valves are even more accessible than in those of the beam-engine, and the up-stroke of the air-pump is effected while the pistons are descending. It is worked simply by two of the side-levers, which form part of the parallel motion, and the feed and the bilge-pumps are worked from the ends of the air-pump cross-head, in the usual way.

The position of the condenser with respect to the cylinders is such as has been found in practice the best, being entirely below them and the slide-valve casing. The injection-pipe plays directly up its centre, and the waste water, falling through its entire depth, effects an immediate and perfect condensation.

The use of a separate air-pump to each engine should be regarded as an indispensable requisite in all engines of large power, as well as such an arrangement of the steam and other pipes and connexions as will allow one engine

to be worked entirely free from the other in case of need: this is the case with the engine before us.

In the improved engine, all the working parts are within reach of the engineer from the lower floor of the engine-room, and there is nothing in motion, save the cranks and shafts above, at a greater height than can be reached from this level, even in engines of the largest class: this will greatly reduce the expense of attending the engine. It has been found that the cost of engineers' wages is greatly increased in beam-engines of large power, requiring a second story and an increased number of hands, whilst no such provision will be required by the present arrangement.

All the moving parts, as the piston-rods, cross-heads, &c. are below the water-line, and, being the most vulnerable parts of the engine, are thus entirely out of the reach of shot, as in the steam-frigate, whilst from the cylinders, which are decidedly the strongest parts of the engine, nothing is to be apprehended from this cause, as the construction of the engine is such that, if even the outer cylinder were disabled, the other one could be kept at work. There is no projection above deck except the ordinary crank-hatches; and the crank and paddle-shafts are precisely similar to those of the ordinary side-lever engine.

The reduction of weight and space as compared with the ordinary engine is very great, and much additional room in the vessel is made available for cargo. The additional length of engine-room that would have been necessary if the ordinary beam-engines and common boilers had been used in the Helen Mac Gregor, in lieu of the improved engines and tubular boilers with which she is fitted, is 25 feet. I beg to annex a few of the

principal dimensions of the Helen Mac Gregor's engines, &c.:—

Cylinders, 42 inches diameter; length of stroke, 4 feet 6 inches.

Air-pump, 33½ inches diameter; length of stroke, 2 feet 4½ inches.

Capacity of condenser, including passage to air-pump, 44 cubic feet.

Capacity of hot well, 36 cubic feet.

Wheel, 23 feet 6 inches diameter to the outside of floats.

Number of revolutions, 23½.

Average pressure of steam in cylinder, 3¾ lbs.

No. XXIV.

ON EDGE'S IMPROVED WATER-METER.

By A. Wright.

Abstract.

The meter consists of a rectangular box, 14 inches long, 13 inches wide and 12 inches high, divided into two chambers by a partition, in the top of which is an aperture forming a communication between the two chambers. A four-way cock is fixed in the partition, the longer end of which opens into one chamber, and the smaller end into the other; the water is conducted to and from this cock by means of tubes passing through one of the chambers.

Parallel with the centre of the cock is a spindle working in upright standards; the spindle carries a